Name: _____ Date: _____ Period: _____

Macromolecules: The Final REVIEW!

Mrs. Krouse, 2015-2016

Identify the elements found in each of the macromolecules by filling in the chart given below.

Except for phospholipids

	Carbohydrates	Lipids	Proteins	Nucleic acids
Always contain P				✓
Generally contain no P	✓	✓	✓	
Always contain N			✓	✓
Generally contain no N	✓	✓		
Frequently contain S			✓	
Generally contain no S	✓	✓		✓

For each of the functional groups listed in the chart below, name the functional group and place a checkmark (X) in the appropriate column to indicate the macromolecules in which that functional group is found.

Functional Group	Name	Carbohydrates	Lipids	Proteins	Nucleic Acids
-OH	Hydroxyl	X	X… see Image A and explanation given below	X… see Image B and explanation given below	X
-C=O	Carbonyl	Sort of… monosaccharides shown in straight chain form have a carbonyl group, but most monosaccharides occur in nature in their ring form (which does not have a carbonyl group)	X… see Image A given below	X… see Image B given below	
-SH	Sulfhydryl			X (found in the R group of some amino acids)	
-COOH	Carboxyl		X… see Image A given below	X… see Image B given below	
$-NH_2$	Amino			X… see image B given below	X (found within the nitrogenous bases of nucleotides)
$-PO_4^{2-}$	Phosphate				X

Image A: In the image given below, we see three fatty acid chains bonding to a glycerol molecule through dehydration synthesis to create a triglyceride (aka fat molecule), which is a polymer of a lipid. Before these building blocks of a lipid

(i.e. glycerol and fatty acid chains) are joined, the glycerol molecule and the fatty acid chains both contain hydroxyl groups (-OH). On the fatty acid chain, the hydroxyl group (-OH) is part of a carboxyl group (-COOH). (Note: The carboxyl group also contains a carbonyl group, which has the formula –C=O.) Once the glycerol and fatty acid chains are joined through dehydration synthesis, 3 –H's are lost from the glycerol and -OH is lost from each of the three fatty acids to form three water molecules. Because –OH's are lost from the fatty acid chains, we no longer have carboxyl groups on the fatty acid chains. Instead, we have a carbonyl group (-C=O) on the fatty acid chain connected to an oxygen atom from the glycerol molecule.

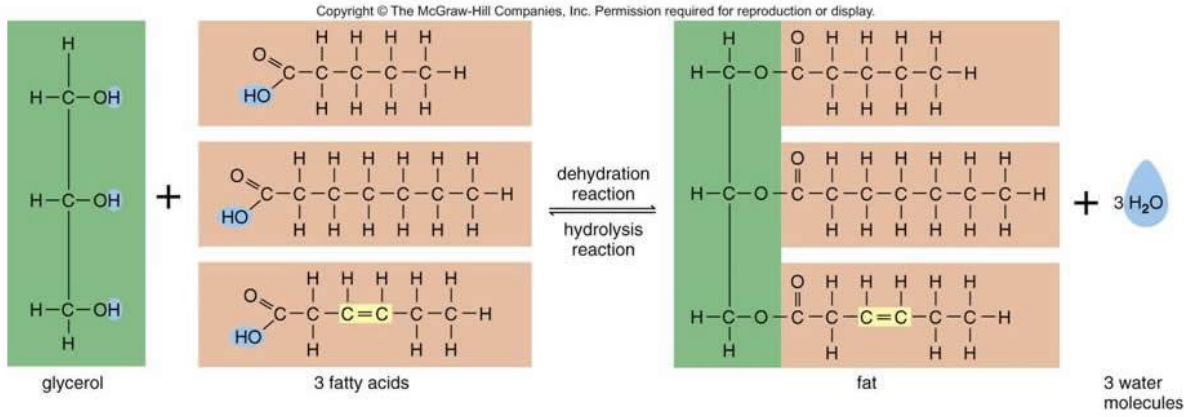
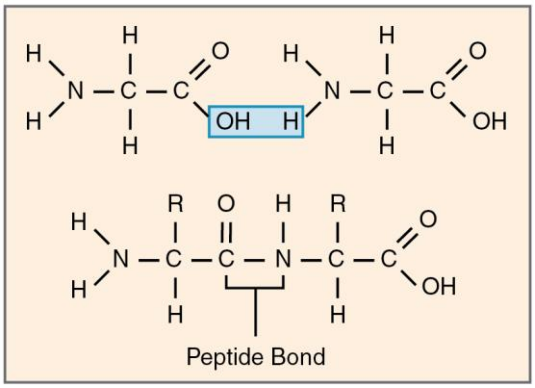
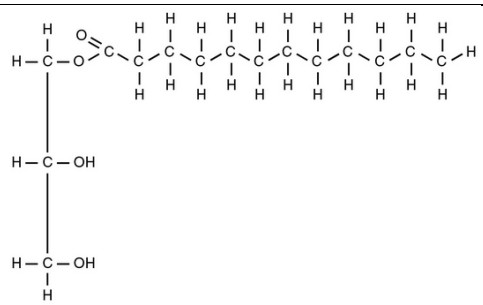
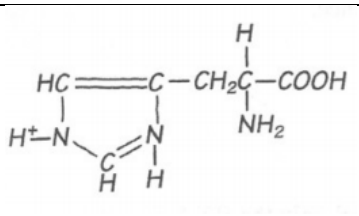
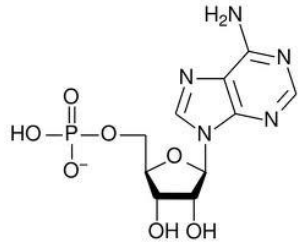
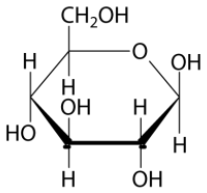
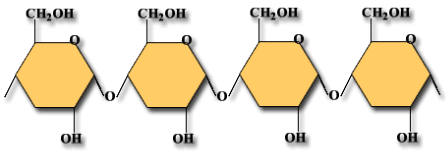
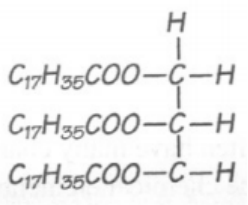


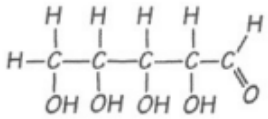
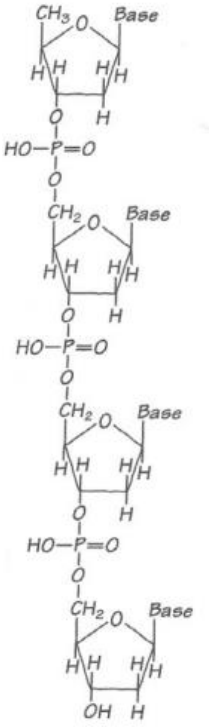
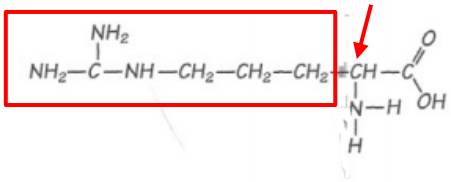
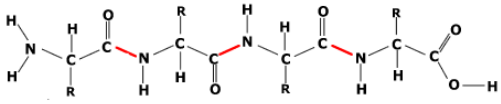
Image B: In the image given below, we see two amino acids joining together through dehydration synthesis to create a peptide bond (i.e. a covalent bond that joins two amino acids). Together they form a dipeptide. The formation of a polypeptide uses the same process but involves more than two amino acids joining in a chain. Before these amino acids are joined, both amino acids contain an amino group (-NH_2) and a carboxyl group (-COOH). (Note: The carboxyl group contains both a carbonyl group with the formula –C=O and a hydroxyl group with the formula –OH.) When they are joined through dehydration synthesis, -OH is taken from the amino acid on the left side of the image. Additionally, -H is taken from the amino acid on the right side of the image. Together the –OH taken from the amino acid on the left and the –H taken from the amino acid on the right form water. In the dipeptide (bottom of the image) that is created through dehydration synthesis, a carbonyl group (-C=O) remains on the amino acid on the left and –NH remains on the amino acid on the right.

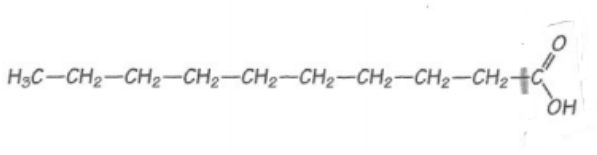


Identify each image in the chart below as either a carbohydrate, lipid, protein, or nucleic acid and either a monomer or polymer.

Note: #'s 1 and 2 have been completed for you as examples.

#	Image	Carbohydrate, Lipid, Protein, or Nucleic Acid?	Explanation	Monomer or Polymer?
1		Lipid	This is a fatty acid chain (all C's and H's) bonded to a glycerol molecule	Polymer
2		Protein	This is an amino acid because it has a central carbon atom bonded to four things… a hydrogen atom, a carboxyl group (COOH), an amino group (NH2), and an R group	Monomer
3		Nucleic Acid	This is a nucleotide because it consists of a phosphate group (contains the atom phosphorus and may be represented by a circle on a diagram), a 5-carbon (aka pentose) sugar (looks like a pentagon), and a nitrogenous base (looks like one ring or two fused rings that contain nitrogen atoms)	Monomer
4		Carbohydrate	This is a monosaccharide in ring form because monosaccharides in ring form typically look like hexagons or pentagons with hydroxyl groups branching off.	Monomer
5		Carbohydrate	This is a polysaccharide because it is made of monosaccharides (look like hexagons or pentagons with hydroxyl groups branching off) connected in a chain	Polymer
6		Lipid	This is a triglyceride (aka fat) because it is made of three fatty acid chains bonded to a glycerol. The fatty acid chains are not actually shown, but we are assuming that in each fatty acid, the 17	Polymer

			carbon atoms are connected in a chain, and the 35 hydrogen atoms are branching off the carbon atoms in that chain. The glycerol is on the left side of the image and contains three carbon and oxygen atoms.	
7		Carbohydrate	This is a monosaccharide in straight chain form because it has 5-6 carbon atoms bonded to each other in a chain with hydroxyl groups branching off	Monomer
8		Nucleic Acid	This is RNA because consists of a single chain of nucleotides. Each nucleotide contains a phosphate group, a 5-carbon (aka pentose) sugar (looks like a pentagon), and a nitrogen base. In the image, the nitrogen base is simply represented by the word “base.”	Polymer
9		Protein	This is an amino acid because it has a central carbon atom (indicated by an arrow in the image) surrounded by four things: a hydrogen atom (shown right next to the central carbon), an amino group, a carboxyl group, and an R group (contains different atoms for each amino acid). The R group is indicated by a box in the image.	Monomer
10		Protein	This is a polypeptide because it is a chain of amino acids. There are four amino acids in this polypeptide. The amino acids are recognizable	Polymer

			because they have carbonyl groups (which used to be carboxyl groups but lost their –OH during dehydration synthesis to join the amino acids) and –NH's (which used to be amino groups but lost their second H during dehydration synthesis to join the amino acids). They also each have an R group (contains different atoms for each amino acid) indicated by the letter "R."	
11		Lipid	This is a fatty acid because it contains a long chain of carbon atoms with hydrogen atoms branching off. Note, the hydrogen atoms are not shown as branching off the carbon atoms in the picture. Instead, they are written in next to the carbon atoms in the chain.	Monomer